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A LEND-LEASE PROGRAM FOR PHILOSOPHY AND SCIENCE*

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Nearly a century ago, some of the most eminent of British scientists were engaged in public agitation upon issues which are still central in all considerations of the place of science in education. The immediate objective of Huxley and his scientific colleagues was the sufficiently modest one of introducing science in small doses into the educational curriculum. At times they seemed to be asking only that science should have, as Huxley said, "as much time given to it as to any other single subject." But the immediate practical issue was merely one aspect of a more inclusive challenge, by the new and still disturbing doctrines of evolution, to established conservatisms and orthodoxies, in philosophy and religion no less than in education.

So it was that the grand debate upon the educational functions of science in an age we are pleased to call "materialistic" was not confined to considerations of direct utility. Naturally enough, the support which education in scientific subjects might give to technological progress and material betterment had great appeal for a generation as devoted as our own to the gospel of getting on in the world. But the contemporaries of Matthew Arnold and Ruskin were forced to think about the *ends* of scientific education, and to examine the details of practical educational reform in the wider philosophical context of the goals of society and the destiny of man.

The case for including science in liberal education was argued on the broad basis of the ability of science to contribute to culture. It was in this spirit that John Tyndall pleaded that his own century had "as good a right to its own forms of thought and methods of culture as any former centuries had to theirs." And Huxley, the most eloquent of all the evangelists for the new outlook, insisted that science had the right to join in the construction of "a complete theory of life." These Victorian scientists in fact were far from endorsing the narrow doctrine that the sole end of scientific instruction might be technical skill—"a process," as Huxley described it, "of manufacturing human tools wonderfully adroit in the exercise of some technical industry, but good for nothing else." For the Victorians, as for us, science must either be an essential component in the "criticism of life" or else have approximately the same educational significance as typewriting, bricklaying, or any other nonintellectual craft.

How far have the hopes for the participation of science in education been realized? If Huxley and Tyndall could be with us today they might take pride in the honorable position accorded to science in contemporary education; but it is safe to suppose they would be sadly disappointed with the fruits of the reform. Scientific ways of thought and investigation have hardly begun to influence social and political affairs; and in spite of Mr. H. G. Wells, science has not made a decisive contribution to the formulation of "a complete theory of life." Science, as now

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taught in the schools and colleges of the western world, supplies neither a guide to action nor a satisfying *Weltanschauung,* and is in some danger of becoming a formal drill as illiberal in its own fashion as the older classical tradition in the days of its decline.

It would be a mistake to explain this relative failure as resulting solely from inadequate teaching methods, deficient physical plant, or the other familiar and persistent obstacles to successful education. The best pedagogical training and the most favorable educational environment will continue to prove ineffective so long as confusion remains concerning the aims of science and its relations to other disciplines. But this philosophical task has been relatively neglected.

While scientists have, in practice, neglected their proper aspirations to join in the creation of a new synthesis of culture in order to concentrate their main educational efforts upon the training of increasingly specialized technicians, their reflections upon the scope and objectives of their own discipline show a corresponding psychological overcompensation. Failure to achieve the cultural and educational objectives of science is accompanied by emphatic advocacy of the universal sovereignty of scientific method. Such pretensions constitute an intellectual isolationism which makes genuine educational advance unnecessarily difficult.

I SHALL assume, from this point onwards, that any substantial progress in the use of science as an educational and cultural agent requires great advances to be made in the common understanding of the specific procedures of the various sciences and their relations both to one another and to non-scientific studies. Since this program needs, as I shall try to show, active cooperation between philosophy and science, the view which is taken of the relations between these two disciplines will have crucial importance. My purpose will be to sketch in brief outline the reasons for the present divorce between philosophy and science and to suggest possibilities for reconciliation in the future. I hope it will be understood that no belittlement of the technological aspects of science is intended; and that if the discussion is conducted at a somewhat rarefied level of abstraction, there is no intention of forgetting the need for testing any educational theory in the light of practical consequences.

OUR discussion has implied a distinction, if not an opposition, between "utility" and "culture," notions as vague as they are indispensable in educational discussion. We shall be seriously misled if we allow ourselves to forget that "culture" is a variable having a wide range of interpretation, and that its adequate definition is itself one of the goals of the philosophy of education.

For Huxley's generation, we may be sure, "culture" tended to have a more personal and individualistic connotation than at present. It might stand for the fullest growth of the individual's latent powers through knowledge of "the best that has been thought and said in the world"—or its meaning might degenerate into the arts of "refined pleasure," providing genteel material for elegant conversation. But in either case the cultured individual of the Victorian conception is too much of an abstraction from his society to satisfy us today. The meaning attached to "culture" is itself one index of a culture's orientation and values.

We can happily find an invariant core of meaning in the alternating shifts from individualistic to social emphases in conceptions of "culture." Whatever else "culture" has meant, there has always been implied *the power to make connections,* to enter through literature and the other arts of human communication into a community defined by shared allegiance to distinctive modes of sensibility, understanding, and appreciation. "Culture" therefore requires the establishment of some *tradition,* no matter how immature or dimly apprehended. As here understood, there will be no highly developed culture without self-conscious awareness of norms and ideals manifested in admired works of the past; and there can be no vital culture where no attempt is made to modify the tradition for projection into the future. The breadth of the culture is determined by the extent to which the tradition is inclusive and tolerant of assimilation and adaptation; the degree to which the de-

fining ideals are explicitly recognized and understood will determine the momentum, the "drive," of the culture.

Where, then, shall we look for the historical origins of a worthy tradition and culture in which science can be required to play an important part? If we are to obtain a tradition deserving of our allegiance we shall need to recognize a continuous background of cognitive aims and methods reaching back to the Ionian Greeks and perhaps beyond. In so doing we are forced to recognize a fact of capital importance to the present discussion, that *in the Greek cultural matrix science and philosophy are interwoven strands in a single intellectual tradition.*

Greek science and Greek philosophy were equally dominated by the ideal of demonstratively certain knowledge; and both accepted essentially the same methods of inquiry and discovery. Not until the seventeenth century, indeed, with the gradual differentiation of experimental methods, "scientific" in a narrower sense, does there arise any "problem" of the relations between science and philosophy. Until that time ". . . there was no break between philosophy and genuine science—or what was conceived to be such. In fact there was not even a distinction; there were simply various branches of philosophy, metaphysical, logical, natural, moral, etc., in a descending scale of demonstrative certainty." The term "natural philosophy," indeed, lingered on until late in the nineteenth century, and in England at least the term "science" hardly reached its present meaning until the founding of the British Association in 1831.

The shift from "natural philosophy" to "science" marked a far-reaching alteration in the conception of the methods appropriate to the study of the physical world. The cognitive ideals of "natural philosophy," as of the other branches of philosophy, had been largely rationalistic. Euclid provided the pattern, and the search for knowledge was regarded as the deduction of necessary truths from intuitively certain premises. For finite human minds sensory experience might be the avenue to a priori truth; but sensory experience was the *occasion* for knowledge, not its locus; truth was to be found in an understanding of the character of an objective, rational, and intelligible cosmos.

The struggle against this type of philosophical position produced radical shifts in scientific ideals. In attacking a rationalism grown dogmatic and scholastic and supported by the formidable joint authority of Aristotle and the Church, the new experimentalists were naturally more conscious of their deviations from the tradition than of their continued adherence to some of its guiding principles; the struggle to institute experiment became oversimplified as the outright rejection of rationalism. The rise of physical science as a separate and distinctive discipline was felt to depend upon insistence on the superior authority of contingent experience; while the fruitfulness of that insistence and the delightful novelty of its products served in turn still further to discredit rationalism. It was in this climate of opinion that there emerged the separation between science and philosophy which is one of the major unresolved disharmonies with which our own times are plagued.

In the popular conception of today, the rationalistic and metaphysical aspects of philosophical activity dominate; and the mention of an Aristotle or a Spinoza evokes the image of stupendous feats of cerebration, always conducted in an arm-chair, directed towards the definitive revelation of the nature of some such mystery as "Being as such." And the practicing scientist, trained in an educational setting indifferent or actively malicious toward philosophical activity and happily unaware of the rationalistic legacy embodied in his own scientific theories, is glad to seize upon the hasty forays of philosophers into the realms of empirical facts as sufficient demonstration of the futility of all methods of inquiry which are not "scientific."

It matters little that the predominantly rationalistic and metaphysical conception of philosophy is a travesty upon history and overlooks the services of Aristotle to biology, Locke to political theory, Hegel to the analysis of social and cultural institutions, and of many another philosopher to empirical studies. Distortions of intellectual history

are none the less potent for being demonstrably false; and all too many of our contemporaries think of the relations or lack of relation between philosophy and science in terms of a stark opposition between experience and reason, fact and speculation, controlled observation and undisciplined imagination.

The most superficial acquaintance with the history of science and the nature of its present methods is enough to show the inadequacy of these crude antitheses. The work of such men as Duhem, Meyerson, and Poincaré has made plain the extent to which science uses symbolical and conventional artifices to organize and purify the crude materials furnished by direct observation. The privileged position of mathematics in relation to modern science is enough to dispose of the myth that the scientist deals with "facts" uncontaminated by any dealings with the methods of discursive reason.

Science, like philosophy, is an amalgam of components both rationalistic and empirical; but according as this fact is recognized or not there prevail a narrow and a liberal conception of the nature of science.

One influential conception is linked with the trend toward specialization which began in physics and has proved most successful in that science. In this sense all studies become "scientific" to the degree that they aspire to reach the condition of physics and seek to imitate closely the complex interweaving of selective observation, controlled experiment, and mathematical elaboration which is to be found there. Those who favor this definition may take as their slogan the epigram attributed to the late Sir Ernest Rutherford that science consists only of "physics and stamp-collecting."

This first sense of "science" and "scientific method," however narrow in application, has the great merit of definiteness. To make physics the paradigm of all reputable knowledge and to advocate the extension of its methods into chemistry and more distantly related subjects is to make a demand of some precision. But it is also to limit the cultural effectiveness of "science" in a manner which few will find acceptable.

For in *this* sense history and the social studies generally can be called "scientific" only by the kind of extravagent courtesy which would justify the description of a monkey as human. From this puristic standpoint the sociology, history, and philosophy of science itself are outside the concern of reputable cognitive inquiry. Where this narrow sense of "scientific" is adopted as standard, the most important fields of human interest and concern are abandoned to the irresponsible fluctuations of opinion or prejudice.

But "scientific" is an honorific term not lightly abandoned for the designation of cognitive pursuits to which importance is attached and upon which reasonable hopes can be set for advance in knowledge. And, as we have seen, "science," as equated with "natural philosophy," has an older and more significant connotation. One who speaks of "scientific method" in this broader sense can, however, hardly hope for definiteness. Indeed, in virtue of the essential continuity of the cognitive enterprise through the centuries, he comes near to meaning by "scientific method" *a good method for achieving knowledge, whatever the characters of that method prove to be.* On this basis, all studies become scientific *in so far as they yield genuine knowledge,* and the field of science is the whole of available knowledge however acquired.

Whatever plausibility is attached to the universality of scientific method in this generalized sense is specious; for the admonition that all studies shall become scientific is then hardly more than an exhortation to look well upon those who have successfully acquired knowledge—and then to go and do likewise. If any attempt is made to delineate the common features of these successful cognitive enterprises, the result is always of unhelpful vagueness and generality.

The most distinguished living advocate of the extension of "scientific method" into all fields of intellectual inquiry, Professor Dewey himself, can supply no better formula than a reference to "systematic, extensive and carefully controlled use of alert and unprejudiced observation and experimentation in collecting, arranging and testing facts to serve as evidence."

How unhelpful such advice can be to anybody who wishes to learn "scientific method" the example of ethics may illustrate. In order to be "scientific" about ethical questions, Dewey tells us, we must collect, arrange, and test facts in a systematic, extensive and carefully controlled fashion. But what is an ethical "fact" and by what signs is it to be recognized and discriminated from sheer illusion? The description of scientific method gives and can give no useful answer. For to be in a position to recognize ethical objectivity is already to have considerable and valuable ethical knowledge. To know what constitutes relevant *ethical* evidence is to be a long way along the road to the possession of ethical truth. There can be little in the analyses of our eminent contemporaries who have essayed to define scientific method to help in the discovery of ethical data and principles. The social studies can hope for little from such general pronouncements; for what they are told in effect is to seek knowledge by recourse to experience and reason; and while the admonition may be salutary and at least shows a sympathetic interest in the outcome of the projected investigation, it remains as indefinite as a pat on the back.

I HAVE been arguing so far that there is a crucial ambiguity in popular conceptions of science and scientific method, reflecting the historical shift from the inclusive aims of "natural philosophy" to the more restricted and specialized purposes of scientific technology; that the claims of science to have distinctive instruments of knowledge are fully justified only in the case of studies whose condition approximates to that of physics; and that elsewhere, in psychology and ethics, in politics and history, in logic and jurisprudence, the advocacy of scientific method is no more than a hope that better knowledge may at some time be achieved by methods at present unknown. All of which, as my readers will by this time have realized, was intended to lead up to a plea for a re-establishment of the ancient alliance between philosophy and science.

Once we have recognized the continuity of philosophical and scientific aims and methods and see clearly that the pursuit of knowledge requires the exercise of both reason and experience, we should be in no danger of setting up unnatural and constricting barriers between the two. And, by the same token, we can then eschew the partisan attitudes which are satisfied by nothing less than the universal dominion of their favorite discipline. The common business of philosophy and science will then be understood as the acquisition of knowledge by a process which in both cases requires the deliverances of sense-experience to be submitted to symbolic elaboration, tested by intellectual procedures established in an effective tradition of criticism and interpretation, and again checked and controlled by reiterated appeal to experience.

Against this general background of agreement in aims and objectives, it will then remain useful to make a broad division of spheres of interest. So long as men have immediate practical concerns, a major human preoccupation must surely remain the pressing of "studies," in Bacon's phrase, "for the relief of man's estate," the active prosecution of medicine, agriculture, metallurgy, electronics, in short of all cognitive activities directed toward humanitarian and utilitarian ends through mastery and control of the material and social environment. When we use the term "science" (as distinguished from "philosophy"), we may well think primarily of *such* activities—utilitarian in objective and technological in execution, bearing in mind, however, that all such practical concerns are inextricably bound up with the so-called "theoretical" or "pure" studies.

But the desire to *understand* is also a distinctively human preoccupation; and so long as men have interests in the ideal, there will persist an active concern in so organizing the cognitive enterprise that there may emerge a coherent, harmonious, and truthful presentation of the manifold variety of the experienced world in such a way as to satisfy the widest range of human commitments and needs. When we use the term "philosophy" (as distinguished from "science") we may well think of cognitive activities so organized—aiming at understanding and

theoretical adequacy rather than immediate practical application and control.

From this standpoint science and philosophy will have as common subject-matter the whole variety of human experience, so far as it lends itself to cognitive elaboration and report; and the two terms will signify different directions of emphasis in an unbroken and indivisible continuum of varying types of cognitive activity. When a researcher is establishing in the laboratory the physicochemical make-up of a virus of equine encephalomyelitis he may be thought of as acting in a fashion extremely scientific in the utilitarian-technological sense; but when the same man or another tries to determine the difference between a virus and inanimate matter he will be verging upon the philosophical. Toward the "scientific" end of our continuous linguistic scale will be found activities highly particularized, technical, self-contained; toward the "philosophical" end activities abstract, generalized, nondepartmentalized. But it will be well to remember that even this cautious differentiation is a device for facilitating exposition and thought, and that a great many cases of cognitive activity will occur so near the middle of the scale as to be regarded indifferently as "scientific" or "philosophic."

Science and philosophy are here being regarded as continuous in subject-matter, ideals, and methods. But unless one is prepared to say that red is the same as orange and an oak nothing but an acorn, it must be admitted that continuity is not the same as identity. Recognition of the unity of philosophy and science need not, and ought not, to preclude differentiation of appropriate procedures and a fruitful division of labor.

Thus the knowledge of the material world yielded by physics is of the greatest value both to science and philosophy; but it would be a ridiculous error to supppose that all questions which arise in connection with physics can be settled *in principle* within the laboratory. It would be impertinent for a layman to praise the experimental procedures of applied physics whose technological consequences are among the special glories of our age; yet the *concepts* of theoretical physics are notoriously opaque even to the most distinguished practitioners in the field. Once we ask seriously for an *understanding* of physics, seek to criticize its epistemological foundations, establish the meaning of its basic terms and their relation to the crude data of common-sense, we enter upon philosophy. To shrug away such inquiries as unimportant is to deny the dignity of science as an enterprise related to understanding as well as control; but to try to answer them by measurement or calculation is to play the part of a philosophical simpleton. Superhuman intelligence might, and genius occasionally does, master both the exacting disciplines of experimental research and the different but no less exacting demands of sound philosophical training; but for most purposes difference of training and specialization will be essential.

The physicist may manage sufficiently well without much knowledge of the history of his subject, since the instruments and techniques of his profession crystallize and embody the *answers* to older questions arising within the discipline of investigation. But for the philosopher of physics the history of science and philosophy is an indispensable propaedeutic. For intellectual criticism has no secure and tangible instruments to match the equipment of the laboratory; the very tools of philosophical analysis must be re-created in the mind by retracing the paths of the great predecessors. So the history of science and philosophy is no external affair of dates and places but itself a philosophical training. Without it the basic terms of philosophical inquiry, "knowledge," "objectivity," "experience" and the rest, are meaningless noises, and the thinker unwittingly reproduces the mistakes and the discarded fallacies of earlier systems. Sound historical study of any subject requires the mastery of techniques of interpretation which are not those of the physical laboratory; and the use of the history of science and philosophy as training in philosophizing requires further canons of interpretation which are not those of the general historian. To this must be added, in any catalogue of desirable qualifications, mastery of the findings of physics at a level of generality neither too far removed from the concrete particulars of the laboratory nor

prematurely committed to uncritical metaphysics. Comparable preparation in the methodology and history of at least one other science is desirable if not essential. When to this has been added the need for mastery of the new and developing fields of symbolic logic and semiotics (each now able to supply full-time employment to appropriately trained specialists) perhaps enough has been said to establish the case for differentiation of function and training.

Philosophy of science (and the wider field of general philosophy into which it merges) can yield valuable results only when pursued with the same seriousness of purpose as technology. When turned into an occasion for amateurish speculation concerning a mysterious universe by eminent scientists writing in a mood of relaxation from more serious concerns, it can serve only the purpose of an elaborate but ill-constructed fairy tale, in which materialism is always the wicked ogre, and "spirit," "value," or some such disembodied abstraction the providential and benevolent godmother.

THE RELEVANCE of this analysis to the formulation of a program of cooperation between philosophy and science should by now be sufficiently plain. The general policy to be adopted will be one of seeking to discourage "mechanical" and to foster "organic" cooperation. By a "mechanical" transaction between systems I understand a process in which the giver remains substantially unchanged by the gift, and may have his initial condition restored by reversal of the operation; exchange of momentum through the collision of elastic bodies may serve as an example. By an "organic" transaction is understood a process which irreversibly alters the character of the participants; and of this the relations between a growing organism and its environment may provide a convenient instance. But we have excellent examples also in "lend-lease" cooperation between political states, where differentiation of function in the service of a recognized community of interests dictates a pooling of resources without a mathematical calculation of immediate profit. In urging the advantages of organic cooperation between science and philosophy there is no need to view mechanical relations with reproach: the two subjects can learn much from one another in ways which, leaving both substantially unchanged, are mechanical in the sense defined. But we may reasonably look forward to more intimate modes of collaboration which may profoundly change the character of both science and philosophy as now understood through the emergence of essentially novel disciplines of cognitive inquiry. What can be done to facilitate such cooperation?

There is, first, a need already pressing for the better dissemination of the findings and methodology of science. The type of exposition required falls somewhere between the highly technical reports of research journals and the diluted and often sensationalized accounts of popularized science. Such work as that of Norman Campbell on measurement and Ernst Mach on the principles of mechanics are excellent illustrations of the type of work needed—and also of the difficulty of the undertaking.

There is a correlative need to make available better expositions of philosophical method in a manner which will effectively assist in the furtherance of the cognitive enterprise. In this field also the same gap exists between the highly technical presentations which fill philosophical journals and the vacuous sensationalism of too many popular guides and outlines to philosophy.

Finally, it will be desirable to initiate programs of joint research in fields where there are yet to be found neither sufficient data nor sufficiently clear understanding of adequate procedures. In sociology and ethics, in education and religion, the methods of science and philosophy will interact in the joint search for knowledge *by whatever means prove effective in practice.*

SUCH a program as this must remain largely tentative in outline, since its definitive character can emerge only through attempts to realize it. To be avoided above all is any premature limitation upon experimentation through antecedent prejudice in favor of methods which have proved their worth in some special field. The standpoint

here advocated sets no arbitrary limitations upon the application of scientific method; it insists only that scientific method be used wherever it *proves* to be effective. We are asking only that the pragmatic temper be applied to the *methods* of scientific inquiry no less than to its findings. In this way we may avoid, both in philosophy and science, the dogmatic provincialism of undue attachment to methods characterizing a provisional stage in human culture and doomed, as all good methods are, to eventual supersession. Science and philosophy practiced in such an undogmatic spirit, recognizing each other's just claims, uniting in the common task of the search for knowledge, may well make contributions of the greatest importance to postwar education.

REFLECTIONS ON ENERGY AND ENTROPY

By Karl P. Schmidt

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ENERGY

The flow of power in moving mass,
The waves of radiant heat and light,
And the electric sky-illuminating flash,
Are forms of energy.

The heat of moving molecule,
And in the recess of the atom,
Disclosed by modern chemistry,
The vast reserves of locked up force
Are also energy.

What is the law by which we unify
All this quicksilver of creation's veins?
These forms of energy exchange, but are not lost.
What is the Universe, and what are we,
Except creative Energy?

ENTROPY

The clock runs down, the water cools,
And Entropy forever grows.
Who shall wind or warm again,
Except with other energy?

The planetary systems are but clocks,
Their energy inexorably flowing
Outward from their central suns;
Which, cooling, keep the planets wound.

Does not the wider universe
Forever trend, by loss of heat,
Toward that last zero of all outer space
When even helium will turn to snow?
If Entropy's to be the end of all,
Who then shall wind us up again?

MEDICAL INTERNATIONALISM

By ROBERT A. MOORE

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IN the spring of 1840 the city founded by Pierre Laclede on the high banks of the Mississippi was a thriving community. The dikes and revetments of the river had been completed by Gratiot and Lee, and there was no longer danger that St. Louis might become an inland city. Steamboat arrivals anually exceeded 1700. The *Missouri Republican* boasted that one could now reach Chicago in three days, and New York in eight or nine. The center of interest at the moment was the manslaughter trial of William P. Darnes, who in an altercation with Andrew J. Davis had inflicted a depressed fracture of the skull with his cane. Judge Bryan Mullanphy presided in the Circuit Court, and Dr. William Carr Lane and Dr. William Beaumont testified.

On the other side of the world in this same spring of 1840 a new epidemic of cholera had broken out in Calcutta. Even if communications had then existed to carry this news to St. Louis it is doubtful whether the editors of the *Missouri Republican* would have given space on the front page to an outbreak of cholera in India. What did disease in Calcutta have to do with the inhabitants of a city halfway around the world? Nothing in 1840; but just nine years later one out of every ten persons in St. Louis was to die of this same epidemic. Let us trace the path by which the germs of cholera were borne by man from India to the Mississippi Valley.

The East India Company had for almost a century held a monopoly on the export of opium from India. Despite a prohibition on the importation by the Chinese government, the trade in 1830 amounted to over two and one-half million pounds. In March, 1839, all foreigners were forbidden to leave Canton, and all opium on shore and on ships in the harbor was seized. The value of this opium was estimated to be $10,000,000. The British Lion was irked by this summary action of the impotent Chinese government and England declared war. British soldiers set sail from Calcutta. Cholera was on the way. Mild to severe epidemics broke out in the Indies and in the port cities of China. Britain won the war and secured cession of Hong Kong and left cholera in China.

For three years the epidemic was swallowed in the wide expanses of southern and central China. A branch passed down what is now the Burma Road to Burma and northeastern India, but the main current was westward with gathering momentum; to Kashgar and Yarkand, in the corner of Sinkiang Province, and across the international border to Bukhara in southern Russia. From this hub of commerce cholera spread along the trade routes south to Balk, Kabul, and Herat in Afghanistan. Another branch passed southward along the river Indus to culminate in an explosive epidemic in Kurachi, in 1846, where at least four hundred and ten cases were observed in one British regiment. The main stream turned westward along the trade and pilgrimage trail to Meshed. The 460-mile jump to Teheran was relatively easy for the now fast-moving epidemic, which was reaching virgin soil where the people had never before been exposed to cholera. Teheran had a population of about 50,000 and only 60 years before had been made the capital of Iran by Agha Mohammed Khan. Caravan routes radiated in all directions, and cholera passed northward along the well-traveled roads to the lands about the Caspian and Black seas, reaching Tiflis, Astrakhan, and southern Russia by the fall of 1846. Moscow fell to the invader in September, 1847. Over one million persons died of cholera in Russia within a few years. In July, 1848, cholera appeared in Berlin and, two months later, in the Atlantic ports of Hamburg and Bremen, ready for the jump across the Atlantic.

The same year was marked by the revolution in Germany resulting in the emigration of over three hundred thousand souls from the oppressions of Europe to the freedom of America. On the twelth of October, 1847, the steamer *Guttenberg* set sail from Hamburg with 250 passengers. Before the landing at New Orleans, fifty-five days later, many

had died of cholera and been buried at sea. Shortly thereafter the steamer *Convoy* cast off from New Orleans and landed at Memphis; the *Amaranth* continued the voyage to St. Louis and when she docked had thirty persons with cholera on board. The first resident of St. Louis to contract the disease was taken ill at 4:00 P.M. on January 5, 1849, and died of cholera in the St. Louis Hospital of the Sisters of Charity at 2:00 A.M. on the next morning. On the same day the Board of Health prematurely declared the epidemic at an end. Deaths in January numbered thirty-three, in February nineteen, in March sixty-eight, and in April one hundred and thirty-one. There were one hundred and ninety-three deaths during the second week of May, but the tidal wave was temporarily halted by the great fire which destroyed the harbor and part of the city. On Tuesday, the tenth of July, one hundred and forty-five deaths in one day were attributed to cholera. Even before this it was evident that drastic action was necessary. On June 25 a mass meeting was called, and the mayor and common council abdicated in favor of a committee with absolute powers and a budget of $50,000. A quarantine was placed on arriving ships. Either from the strenuous efforts of the Ward Committee on Health or from the natural course of all epidemics, cholera subsided to endemic proportions by September, having taken a toll of 4,557 dead out of a population of 50,000.

It is not a part of this story to follow cholera to St. Joseph and out the Oregon-California trail to San Francisco, or to trace its importation into Boston and New York. The reason why St. Louis should have been interested in Calcutta in 1840 has been given. There could be no stronger support for the statement published each week in the Public Health Reports: "No health department, state or local, can effectively prevent or control disease without knowledge of when, where, and under what condition cases are occurring."

Medical Nationalism. The cholera epidemic of 1840 to 1850 is a striking example of the world-wide sweep of a disease: at the time, it was a disaster that shocked America to constructive action. The health officers already knew that quarantine regulations did not adequately protect the inhabitants of the port cities. Furthermore, regulations varied from city to city, and what was good practice and safe in New Orleans was bad practice and unsafe in New York. Nothing could be gained by exclusion of the disease at New York if it could be introduced through the back door by way of Boston or Baltimore. Merchants complained that some quarantine laws were cumbersome and restricted or delayed the movement of goods.

Undoubtedly many people, both medical and lay, were thinking about the problem, but one man did something. Dr. Wilson Jewell, a member of the Philadelphia Board of Health, suggested that a national convention of health officials be called. On October 29, 1856, a committee of three from the Philadelphia Board of Health was appointed to correspond with the Boards of Health of Boston, New York, Baltimore, and New Orleans on the propriety of calling a convention "for the purpose of a conference in relation to the establishment of a uniform system of revised quarantine laws." The convention met in April, 1857, with fifty-four delegates and, in a three-day session, passed many resolutions. "Stagnant and putrid bilgewater . . . filthy bedding and baggage" were condemned. Vaccination against smallpox for those not protected was recommended. Second and third conventions met in 1858 and 1859. At the third a resolution to abolish personal quarantine of patients with yellow fever was accepted eighty-five to six. The fourth convention met in Boston on June 14, 1860, under the presidency of Dr. Jacob Bigelow. A short paragraph from his address gives an excellent picture of the times:

> Our lot is cast in a perilous age. . . . Where shall we fly to escape from east winds and dog days, from pestilences that come and pestilences that do not come, from ships that bring us yellow fever, and quarantines that nourish and cultivate it, from cattle diseases that cannot be exterminated by exterminating the cattle, from lead pipes for water contrived to kill everybody except the animalcules, from fraudulent food and deleterious physic, from drugs that are poisonous and poisons that are adulterated, from infectious patients whose pulses must be felt with a pair of tongs and their chests explored with a tarred stethoscope!
>
> There are perils of nervous men and nervous com-

munities. . . . Like the amphibious animal of the showman who dies in the water and cannot live upon land, it is in vain that the unhappy inquirer resorts to his statistical tables to inform himself whether there is most danger in a steamboat or on a railroad—he unfortunately learns that the most dangerous thing a man can do is to go to bed, for more people die in bed than anywhere else.

For these evils, and many others yet unknown, we trust that the wisdom of future conventions will yet devise a remedy.

The next meeting was to be held in Cincinnati in May of 1861, but a shot at Fort Sumter intervened and the United States lapsed back to local control of disease. Twelve years later, in 1872, the American Public Health Association was organized. Article II of the Constitution states: "The objects of this Association shall be the advancement of sanitary science and the promotion of organizations and measures for the practical application of public hygiene."

In the first century of our existence as a nation legal opinion was to the effect that quarantine, both internal and external, was a governmental function reserved to the states. The health officers of ports had found it necessary to band together into voluntary conventions and accomplish by mutual cooperation what the lawyers said was unconstitutional. Enlightened public opinion was just thirty-one years ahead of the Congress and the Supreme Court. In 1878 the Marine Hospital Service, which had been founded in 1798 to care for sick merchant seaman, was authorized by Congress to impose a quarantine to prevent the entry of disease from abroad. The law was extended in 1890 to include imposition of quarantine to prevent the interstate spread of disease.

Medical nationalism was thus finally achieved, with the states in concerted action to protect the health of the whole nation. Out of sheer terror and suffering the people grasped at those opportunities for self-protection which public health practices seemed to offer.

An Island in a Sea of Disease. Those of us who have lived the greater part, or all, of our lives in the twentieth century have little realization of the sheer terror and suffering caused by disease in the preceding century and even today in many parts of the world. Let us examine the evidence to support the thesis that the United States is an island in a sea of disease.

Malaria is the greatest disease of all. It is conservatively estimated that there are 300,000,000 people in the world suffering from malaria. In India alone there are about 100,000,000 victims, or almost one person in every four. There are over 2,000,000 deaths each year in India directly or indirectly caused by malaria, more than the total deaths from all causes in the United States. What would be our economy if there were forty million persons with malaria instead of the one million which we do have? There are parts of the world where conditions are even worse than in India. An examination of about 7,000 persons in Para, Brazil, showed that 45 percent had malaria. In the British Solomon Islands it is estimated that 90 percent of the natives have malaria. In Burma the death rate for malaria in 1931 was 127 per 100,000 population.

In many parts of the world other dangerous infections are unchecked. Between 80 and 95 percent of the people on Hainan Island have hookworm. In China there are 35,000,000 persons with active tuberculosis, 4,000,000 lepers, and 15,000,000 individuals blind because of trachoma, smallpox, and gonorrhea. Filariasis exists in 35 percent of the population of Ceylon. Annually in Greece there are about two million cases of malaria and a million and a half cases of dengue fever. The death rate in Java is 20 and in India is 24.8 per 1,000 population, as compared with an average of 10 in the United States. The mortality from typhoid in Batavia, Dutch East Indies, is 365 per 100,000. In 1943 there were no fewer than 125,000 cases of epidemic typhus fever in North Africa from Casablanca to Port Said.

Provisions for the care of the sick throughout the world vary inversely with the incidence of disease. The latest available statistics have been collected by the Division of Preventive Medicine, Office of the Surgeon General, United States Army. In the United States there is approximately one physician for each 745 in the population; in Ceylon the comparable figure is 6,400; in the Netherland East Indies 1,139; in India 10,000; in China 45,000; in New Guinea 27,000; and in

the Solomon Islands 12,000. In the United States there are 9.7 hospital beds per 1000 population. The figures for Ceylon are 1.7; for the Netherland East Indies, 0.9; for India, 0.3; and for China, 0.06.

The Consequences of the Introduction of a Disease. With good sanitation and reasonable care an epidemic of an intestinal disease transmitted directly from man to man, such as cholera, will gradually die out completely. But the story of a disease with an animal reservoir of infection is quite different. Let us follow the travels of bubonic plague, especially as they concern the United States.

Plague is a disease caused by a bacterium and occurs not only in man but in rats and other rodents. The rat flea feeds on a sick rat and takes up the bacteria from the blood into its stomach. The flea may then bite a man and thus transfer the bacteria. Man becomes ill and the lymph nodes enlarge and produce swellings, or buboes, which give the name to bubonic plague. Rarely the bacteria are passed from man to man in droplets, as is the virus of the common cold. This type is known as pneumonic plague.

On March 6, 1900, a Chinese man living in the Chinese quarter of San Francisco died of plague—the first recorded appearance of plague on the North American Continent. What followed in the next few years is one of the brightest and the darkest chapters in the history of the control of the disease in this country. Plague was a loathsome disease associated with vermin and no self-respecting American city in 1900 could admit harboring it. Accordingly, newspapers, public officials, influential citizens, and even the courts and the medical profession denied that plague was in San Francisco in 1900. Unfortunately, rats could not read the newspapers and continued to scamper about the Golden Gate. Infected fleas passed from one generation to another, occasionally seeking new pastures in the deep furry coat of a ground squirrel. The rodents, rats, and ground squirrels moved east, and by 1910 the migration had proceeded halfway across California. In 1930 the western border of Montana had been reached, and in 1940 the advancing edge was well into Montana, Wyoming, Utah, and New Mexico.

So long as sylvatic plague remains in a rural and thinly populated region it is not a serious problem, except to the hunter or farmer who handles a sick or dying animal. But now infected rodents are approaching within striking distance of the dense rat and human populations of the large cities of the Midwest. No one knows just when or how the plague bacilli filtered through the quarantine at San Francisco, but since 1900 no less than 499 individuals have fallen ill and 314 have died of plague in the western and southern United States. Herculean efforts of the United States Public Health Service have kept the disease under control much as the coal-mine fires of southern Ohio are controlled—always smoldering, rarely bursting into flame, but never extinguished.

This 44-year experience with plague should teach us that we cannot, even with modern medical science, erect a leak-proof wall around the country. Medical isolationism is as fallacious in concept and practice as economic and fiscal isolationism.

A Disease Is Conquered. Yellow fever is caused by a virus and is carried from man to man, and probably from animals to man, in most instances by the mosquito, *Aedes aegypti.* Infected mosquitoes and sick human beings followed the great routes of sea trade. Periodically major epidemics appeared in the port cities of the world. Examples are: Barcelona in 1821 with 20,000 deaths; New Orleans in 1878 with 4,046 deaths; Philadelphia in 1803 with 3,900 deaths; and thirteen times in New York between 1791 and 1807 with a loss of a tenth of the population. The last great epidemic was in Rio de Janeiro in 1928–29 with 435 deaths.

Throughout the nineteenth century health officers struggled against the unknown. The terror in Philadelphia in the 1793 epidemic was recorded for posterity by Dr. Benjamin Rush. People fled from the city, friend avoided friend, relatives were abandoned to die in solitude, burials were made unceremoniously with only the negro driver of the death cart present in the middle of the night.

Armies had come to grief in the western Indies. Napoleon's troops sent to reconquer Haiti in 1800 were wiped out by yellow fever,

as his grand army was decimated by dysentery and typhus in Russia. Toward the end of the nineteenth century American troops occupied Havana, which had been visited by yellow fever every summer in memory. William Crawford Gorgas, a young American physician, was appointed chief sanitary officer of Havana in 1898. He believed that yellow fever was caused by filth and set out to houseclean Havana in the most approved New England fashion, to the delight of the American press. The next year there was another devastating epidemic of yellow fever. The situation was so serious that in 1900 the Surgeon General of the United States Army appointed a commission to visit Cuba and investigate the cause of yellow fever. These were the men—Walter Reed, James Carroll, Jesse W. Lazear, and Aristides Agromonte—who were to solve one of the most baffling of mysteries—the transmission of yellow fever.

In 1793 Dr. Rush had noted that "moschetoes" were plentiful around Philadelphia, and Noah Webster in New York in 1795 wrote "musquetoes were never before known by the oldest inhabitant to have been so numerous." As in the rare conjunction of the planets, the year 1900 and the city of Havana brought together a galaxy of men—Reed and his commission, Gorgas, Dr. Henry R. Carter, and Dr. Carlos J. Finlay. Several years before in Virginia, Carter had collected data suggestive of an insect vector. Carlos Finlay, the prophet without honor, had for years insisted that yellow fever was transmitted by the mosquito.

The product of the joining of these minds is well known and has been immortalized in words and picture as the victory over "yellow jack." Immediately Gorgas took up the war on yellow fever, but this time with precise knowledge to guide him. The breeding places of the Aedes mosquito were eradicated. The work began in March, 1901. There were only five deaths that summer in Havana, and none in 1902, 1903, and 1904. In 1905, there was a mild outbreak, quickly brought under control. Since then yellow fever has lost its sting in Havana. Research had once again penetrated one of Nature's secrets cleverly hidden for ages. This is not the place to relate how Gorgas went on to Panama and, by the same methods, conquered the jungle and made possible the construction of the Panama Canal.

The eradication of a mosquito from a large tropical country like Brazil is not utterly impossible: in fact, the Brazilian government and the International Health Board of the Rockefeller Foundation can proudly point to the fact that because of work begun in 1926 no aegypti-transmitted yellow fever has been seen in Brazil since 1937. To accomplish this result required determination, constant vigilance, and strict control. These are a few of the regulations of decree #21, 434 of the Brazilian government:

Article I. Personnel of the yellow fever service shall visit weekly . . . . all premises, inhabited or otherwise. . . .

Article II. Physicians of the service . . . . shall have immediate free entry at all times to all places.

Article X. The mosquito-proof closing of all water containers of every description is obligatory.

Article XVI. Only basements which may easily be inspected and will absolutely not collect water shall be allowed.

Article XVIII. The pavement of open areas and of walks shall be level without any depression, and have a sufficient incline for the water to drain away readily.

Article XX. Ornamental work, façades, caves, stone carving roofs, and awnings of buildings shall be constructed in such a manner that they cannot collect water.

Article XXIV. Metal roofs shall not be constructed of sheet metal that can be easily bent and may therefore collect water in the depression thus formed.

Article XXVIII. Drinking water receptacles for animals . . . . shall be so designed that they can be quickly and completely emptied.

Article XXIX. Flower vases, jars, jardiniers, and other ornamental articles in cemeteries shall never be allowed to contain water.

Article XXXV. Plants, which by the arrangement of their foliage are able to collect water . . . . shall at the discretion of the service be destroyed.

Article XXXVI. The use of unsplit bamboo for the construction of enclosures, or as fence, is prohibited.

Article L. The use of old automobile tires as fenders on the sides of watercraft shall be permitted only when the holes made in them are not less than an inch and a half in diameter and not more than twenty centimeters apart, so that they cannot retain water.

Call this regimentation if you wish, but, after all, government is the banding together of people for the common good. Which is worse—to build an ornamental roof in a specific way or to die of yellow fever? Yellow

fever has not yet been completely conquered, but the terrifying threat of the major epidemics of the nineteenth century has been banished.

The Beginnings of Medical Internationalism. At about the same time that Dr. Jewell sought cooperation of the health officers of the eastern port cities of the United States, the governments in the Mediterranean Basin looked about for some integration of sanitary regulations. The opening of the Suez Canal was responsible for the first real international sanitary code, subscribed to by fourteen governments in 1892. In 1893 ten European states agreed to notify one another of the outbreak of cholera and provide measures to control this disease.

In the Western Hemisphere in 1887 Uruguay, Brazil, and Argentina signed a sanitary code covering their water frontiers in relation to cholera, yellow fever, and plague. A second attempt at international cooperation in 1904 was subscribed to by Argentina, Brazil, Paraguay, and Uruguay. Finally, the sanitary convention in 1905, ratified by fourteen countries, marked the beginning of the present Pan-American sanitary code, signed at Havana November 14, 1924, and enforced by nineteen governments. The objects of this code are stated in Article I:

1. The prevention of the international spread of communicable infections of human beings.
2. The promotion of cooperative measures for the prevention of the introduction and spread of disease into and from the territories of the signatory governments.
3. The standardization of the collection of morbidity and mortality statistics by the signatory governments.
4. The stimulation of the mutual interchange of information which may be of value in improving the public health and combating the diseases of man.
5. The standardization of the measures employed at places of entry for the prevention of the introduction and spread of the communicable diseases of man so that greater protection against them shall be achieved and unnecessary hindrance to international commerce and communication eliminated.

The signatory powers to the Versailles Treaty agreed to "take steps in matters of international concern for the prevention and control of disease." This was the first time an important political treaty gave consideration to health. In accordance with this broad principle, three organizations were established: a health committee of twelve members, an advisory council, and a health section of the secretariat of the League of Nations. The actual practical work of the League has been along two lines: creation of a service of epidemiologic intelligence and public health statistics in Geneva and in Singapore; and the constitution of expert commissions to study specific problems. Madsen summarizes the accomplishments of the malaria commission as follows: ". . . establishing methods of investigation and so determining the extent and degree of gravity of malaria in the world; organization and training of malariologists who have in turn organized the antimalarial services in their respective countries; laying down methods and principles of treatment and, so far as possible, standardizing methods of work; setting on foot an extensive program of coordinated research . . . in various malarial countries . . .; and the committee has always been at the disposal of malarial countries for purposes of investigation and to assist them in organizing their malarial services." There have been commissions on tuberculosis, syphilis, rabies, leishmaniasis, leprosy, rural hygiene, typhoid fever, physical education, biological standardization, and nutrition.

Although the League of Nations had some noteworthy failures in the field of international political relations, collaboration between nations in health work was a success. The protection against pestilential diseases was stronger in 1939 than in 1920, largely because of international collaboration. The gains in the interim of peace must not be lost in the shambles of World War II.

The Threat in a Modern World. The threat of world-wide visitations of pandemic disease are still in existence. Only twenty-six years ago influenza spread like a prairie fire over the greater part of the earth. In the United States alone there were no fewer than 548,000 deaths. The epidemic of yellow fever in Rio de Janeiro in 1928, with 435 deaths, has been referred to.

New inventions and advances in transportation and communication bring their special problems. The airplane has brought the disease-ridden tropics within a few days' or hours' journey of our country. Let us re-

turn to the steamer *Guttenberg,* which took fifty-five days to cross from Hamburg to New Orleans. If anyone went aboard in Germany during the incubation period of a disease he would have become ill before arrival in the United States. Today a person may be bitten by a mosquito or sandfly in India, China, Africa, or South America and be in the U. S. many days before there are symptoms of illness. Actually, the health authorities keep in touch with every passenger who comes into this country from the tropics for fourteen days after his arrival. Shortly after the airplane lands, the commissioner of health in the home town of each passenger is notified by telegram and asked to report any illness in this person during the stated period.

An even greater threat than the importation of a sick human being is the insect "stowaway." A mosquito carrying the organisms of malaria in a salivary gland may secrete itself in a corner of an airplane and move from one continent to another. This actually happened a few years ago when the gambial mosquito crossed the South Atlantic from Africa to the hump of Brazil. This kind of mosquito above all others delights in biting man, and therefore is especially dangerous if it transmits disease. In Brazil this mosquito did transmit malaria. After a vigorous campaign the Brazilian government and the International Health Board of the Rockefeller Foundation have succeeded in eradicating the gambial mosquito from Brazil. A new type of disinfection and quarantine has been designed to cope with air transportation.

Looking at medical internationalism in terms of dollars and cents, we are told that our postwar economy must include a tripling of exports. The attainment of full export trade would be easier if the millions to whom we are to sell were healthy enough to work and earn enough to buy our goods. Some years ago the average cut of sugar cane per native on a certain tropical plantation was about one ton per day. Swamps were drained, mosquitoes were eradicated, and the average cut rose to about two tons per day. The cost was more than returned to the owner in a few years, but, more important, this little spot on earth became a better place to live in. We are not our brother's keeper but we are all our brother's helper.

The Dawn of a New Day. Despite all that has happened in the past, and all that might happen in the future, many see the dawn of a new day.

During a war the pressure for new discoveries is greatly increased and the old maxim "necessity is the mother of invention" is once more confirmed. Our ideas of the world and its problems are sharply focused and crystallized. The past is truly only prologue.

The supreme test of whether or not modern medical science had outgrown its swaddling clothes came shortly after Pearl Harbor. The United States Army was confronted by the largest and the most complex problem of health protection that has ever been faced by a military force of any nation. Army and Navy posts circled the globe; troops were stationed in every conceivable environment from the land of perpetual snow to the steaming jungles of India, Burma, and the Islands of the Southwest Pacific. Could medical science conquer disease under unfavorable circumstances in a few months in a manner comparable to what had taken years in the mild north-temperate climates of Europe and North America? The answer is written in the accomplishments of the Army Medical Corps, the Naval Medical Corps, and the United States Public Health Service during the past three years.

In November, 1942, American troops invaded North Africa. Among the natives there were 125,000 cases of epidemic typhus fever. Vaccination, adequate sanitation, and the now-famous DDT were used; the number of cases of epidemic typhus among our soldiers can be counted on the fingers of one hand. With few exceptions the experience with other insect-borne diseases has been the same. General Simmons, in April 1943, stated: "No authentic reports have been received of cases of yellow fever, plague, sleeping sickness, or relapsing fever" in American troops. A notable exception has been, and is, malaria. However, the reports are most encouraging in contrast with what might have been. For the decade before the war the annual admission rate per 1000 enlisted men for malaria varied from 1.5 to 5. Despite the heavy concentration of troops in the Fourth Service Command (that is, in the

South) the admission rate in 1942 was only 0.6 in the continental United States. Although the figures for troops in tropical and subtropical regions at first glance are high, the natives in these same regions show a far greater incidence. General Simmons gives figures for five unspecified theaters of operation as follows: 47, 53.5, 106, 173, and 38. The highest hospital admission rate for all disease in any theater of operation is 1091 as compared with 755 for the continental United States. Who would have been so foolish ten years ago as to predict that hundreds of thousands of young American men could be taken to every part of the world with a maximal increase of only 45 percent in hospital admissions for all disease.

It is possible that military discipline is sufficient to protect the men in the Army. What of civilians? With the same methods can medical science meet a major epidemic in a population that has been trampled under the hoofs of the Four Horsemen? The answer is, Yes! and the best example is the epidemic of typhus fever in Naples in the winter of 1943–44.

In the spring of 1943 there were a few cases of typhus in Naples, but no one paid much attention to them. Through the summer an occasional person fell ill with typhus. This was the danger sign. Whenever an epidemic disease of winter persists through a summer an explosion the next winter may be anticipated. The allied Armies took Naples in the fall of 1943. The ragged, underfed population, living under adverse conditions for many months, was an ideal soil for typhus. In December the weekly figures for cases of, and deaths from, typhus steadily mounted. By Christmas it was evident that something had to be done. A group from the headquarters of the U. S. Typhus Commission in the Near East was sent to Naples.

Epidemic typhus is a disease caused by a small parasite, called a Rickettsia, and transmitted from man to man by the bite of the body louse. It is a lousy disease, both literally and figuratively. A logical approach to prevention is, therefore, the eradication of all body lice. Lice leave an infested man soon after his death, and hence the immediate neighborhood where a death has occurred is highly dangerous. Fortunately, DDT had just become commercially available. The U. S. Typhus Commission went to work, and the folk of Naples were scientifically and systematically deloused, giving attention to the three groups: inhabitants of a district where a death had taken place, contacts of living patients, and the population at large. Vaccine was used where indicated. By February the epidemic was over. This means little to anyone who does not know something of the natural history of an epidemic of louse-borne typhus. From too much experience we know that an epidemic with the background of the 1944 Naples explosion would have been likely to continue on a plateau from February to May and subside only during the early summer. Few doubt that preventive medicine cut short the life of epidemic typhus in Naples.

MEDICINE and the physician have in their hands the most precious thing in the world—human life. In the name of humanity, if not in the name of our own health and economic stability, America must participate in a world unit of health, a part of a greater organization to include economics, finance, trade, social relations, and the many other aspects of modern life. Only then will man attain the full stature for which he went through the renaissance, the industrial revolution, the French and the American political revolutions, and two World Wars.

DESERT CHANGE: A STUDY OF THE BOULDER DAM AREA

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THE Boulder Dam area represents a significant portion of the southwestern dry lands of the United States. Moreover, it is a section of the dry country in which the occupance factors have been changing with inordinate swiftness, especially since 1930, and one in which they have progressed to the point of relatively broad geographic importance. This article proposes to describe the changing scene, using the past as a marking-gauge and carrying "the present" up to "the year of Pearl Harbor," 1941. The exigencies of war prevent discussion of factors involved in the immediate present, including several types of military camps, large areas commandeered for military training purposes, the completion and operation of one of the world's larger magnesium plants, new road construction, increased travel, and population increase. Future studies are contemplated, and it will remain for them to analyze the effects of war-impact on the area. Fortunately such a break in the study is logical inasmuch as the present conflict is having

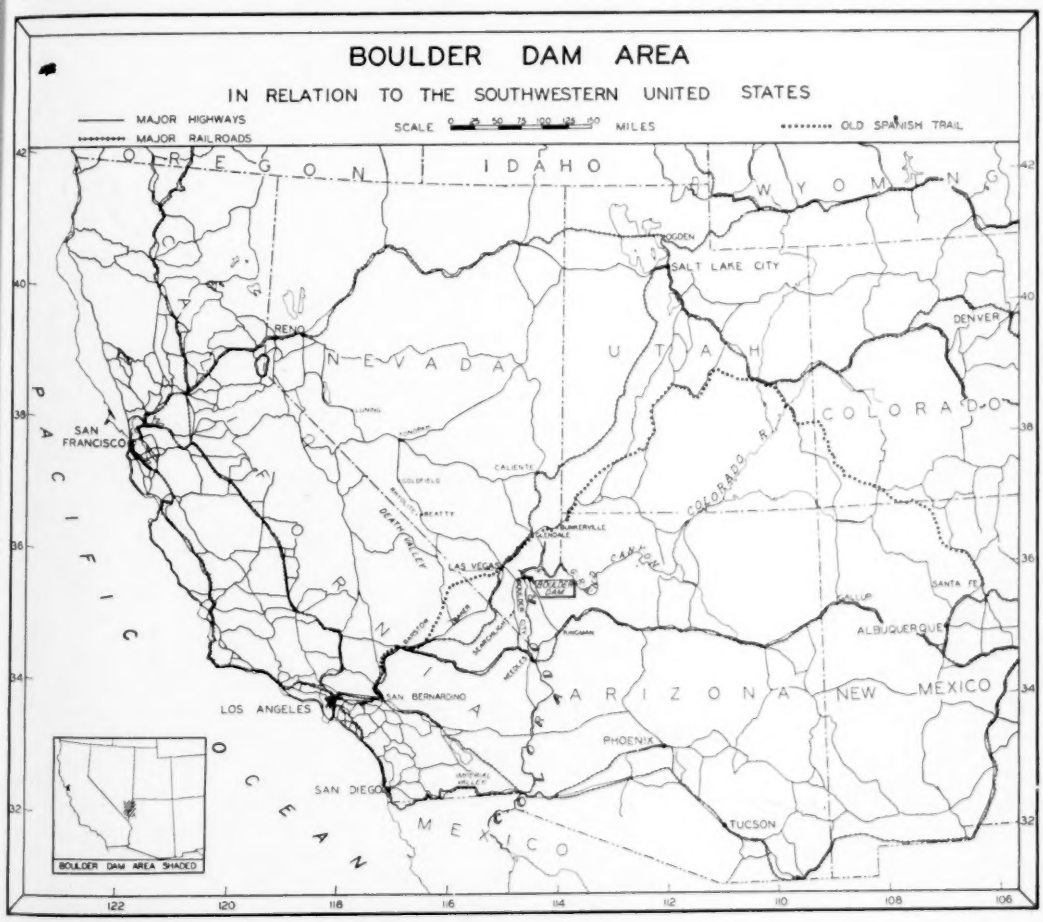

FIG. 1. GENERAL LOCATION MAP

NOTE THE POSITION OF BOULDER DAM WITH REFERENCE TO POPULATION CENTERS, MAJOR HIGHWAYS, ETC.

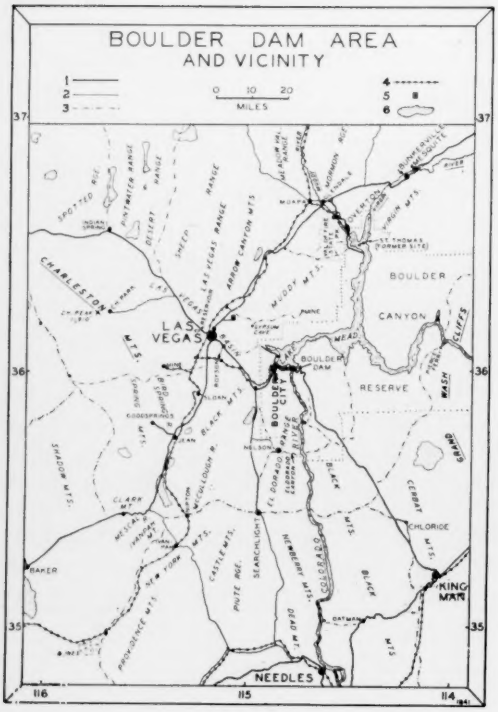

FIG. 2. LOCATION MAP[1]

SHOWING THE CENTRAL POSITION OF BOULDER DAM AND LAS VEGAS AND THE CIRCULATORY SYSTEM OF THE AREA. RARELY USED DESERT ROADS ARE NOT SHOWN.

many direct and far-reaching effects on the Boulder Dam area, effects which cannot, in any event, be properly comprehended or projected at this time nor, probably, for several years after the cessation of hostilities.

The area occupies a large section of extreme southeastern Nevada and reaches into northwestern Arizona (Fig. 1). It has a north-south extent of some 90 miles, from the head of the Virgin river arm of the Lake Mead reservoir to the latitudes of the famous old mining town of Searchlight. In east-west spread it stretches from the lower end of the Grand Canyon and the bold escarpment of the Grand Wash Cliffs, on the east, across the reservoir waters and the alluvium-floored Las Vegas basin to the high ramparts of the Charleston Mountains, a distance slightly in excess of 100 miles (Figs. 2, 3).

[1] The key at the head of the map is as follows:
1. First-class highways (modern, wide, all-weather);
2. Second-class roads (usually narrow, all-weather);
3. Third-class roads (narrow, impassable at times);
4. Railroads; 5. Airports; 6. Playas ("dry lakes").

Being a desert region in every sense of the word, the most visibly conspicuous features in the broader geographical scene are the landforms (Figs. 3, 4, 5). Rugged, scantily clothed mountains, marked by pronounced north-south trend, comprise the bulk of the view (Fig. 3). On the east is the layered edge of the Colorado plateau (the Grand Wash Cliffs) and on the west the steep and jagged wall of the Charleston Mountains. Set down in between the north-south trending mountains are numerous elongated, trench-like valleys and a few less-attenuated basins (Fig. 11). Parched and windswept, these lower sections are being slowly filled and dammed by the ever-encroaching alluvial fans and, as indicators of the extreme desiccation, are dotted with many salt flats or "dry-lakes" (Figs. 4, 6). Cutting through higher and lower levels alike, and at the

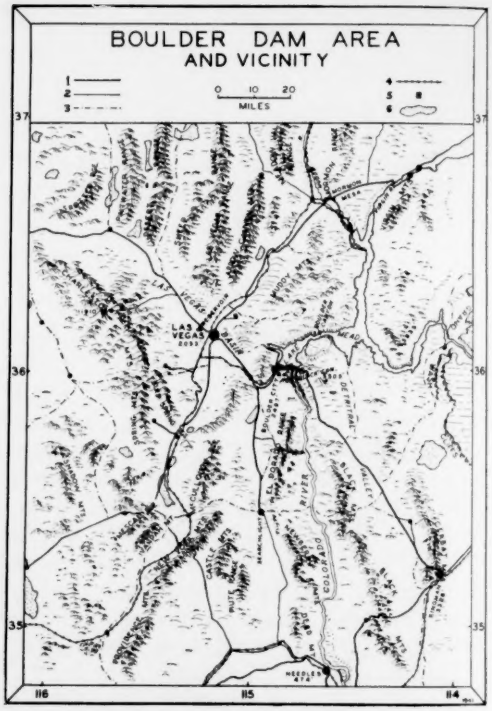

FIG. 3. PHYSIOGRAPHIC MAP[1]

NOTE THE NUMBER AND CONSPICUOUS NATURE OF THE HILLS AND MOUNTAINS WHICH BORDER AND ENCOMPASS THE DESERT BASINS. THE NORTH-SOUTH "STRIKE" IS READILY APPARENT, AS IS THE WASH-BOARD EFFECT OF THE TOPOGRAPHIC COMPLEX. THE GRAND WASH CLIFFS, MARKING THE LAYERED AND TURRETED EDGE OF THE COLORADO PLATEAU, APPEAR IN THE MIDDLE OF THE MAP'S EASTERN MARGIN.

Fairchild Aerial Surveys photo

FIG. 4. A PORTION OF THE BOULDER DAM AREA SOUTH OF THE LAS VEGAS BASIN.
A LAND OF PLAYAS, ALLUVIAL FAN FILL, AND BASIN-ENCLOSING MOUNTAINS (SEE FIG. 2 FOR LOCATION). THE PLAYAS ARE ROACH DRY LAKE, TO THE RIGHT, AND IVANPAH DRY LAKE, TO THE LEFT. THE DARK LINE WHICH BISECTS ROACH DRY LAKE IS A PART OF THE LOS ANGELES-SALT LAKE HIGHWAY. THE VIEW IS WESTERLY.

same time partially ignoring the present "landform grain," is the great elbowed slash of the Colorado gorge, the river itself lying as a meager thread far below the majority of the basin floors.

Considering the ruggedness of the relief, the degree of moisture deficiency, and the blinding heat of the long summer period, it is difficult to think of this "washboard of hell" as a habitable land. Yet man has been in the scene, regardless of numbers and importance, for some eight millenia and, most significantly, now seems well on his way to a more and more permanent maintenance of his establishments.

The first dwellers in the apparently unchanging physical setting were the small, obscure, and exceedingly primitive Indian groups of about 8000 years ago. Only relatively less obscure and few were the more recent Indian populations represented, in order, by the Basketmakers and the Pueblos. Finally in the Indian picture are the Paiutes, who are still in the region; they, however, represent a much more primitive group than the forerunning Pueblos. None of the Indian groups accomplished any truly significant modification of the landscape, although it is probable that early hunting and collecting had some effect on the plant and animal life. In addition, the few and small communities of the Pueblo peoples represented a beginning, especially in the Virgin river area, for sedentary agriculture, carried on under irrigation, by closely knit groups. The Paiute, now a laborer on ranch or railroad, or an inhabitant of the Indian Reservation at Moapa, still plays an insignificant role in the area.

The story of the first penetration of the region by the white man is not completely known. It seems that about 1774 some mining was carried on by Spaniards in the southern part of the area, as, for example, in Eldorado Canyon (Fig. 2). This, however, did not represent a permanent in-